

WHAT IS CLAIMED IS:

1 1. A method for filtering signals to obtain a desired passband of
2 frequencies, the method comprising:

3 providing a micromechanical filter apparatus including a
4 micromechanical resonator having a fundamental resonant mode formed on a
5 substrate and a support structure anchored to the substrate to support the resonator
6 above the substrate; and

7 vibrating the resonator so that the apparatus passes a desired
8 frequency range of signals while substantially attenuating signals outside the desired
9 frequency range, wherein the support structure is attached to the resonator so that
10 the resonator is isolated from the support structure during resonator vibration.

1 2. The method as claimed in claim 1 wherein the step of
2 vibrating includes forcing different portions of the resonator to move in opposite
3 directions at the same time so that the resonator vibrates in a resonant mode, m ,
4 higher than the fundamental resonant mode wherein the resonator has $m+1$ nodal
5 points.

1 3. The method as claimed in claim 2 wherein the
2 micromechanical filter apparatus includes a plurality of input electrodes spaced
3 along the resonator to allow electrostatic excitation of the resonator and wherein the
4 step of forcing includes the steps of applying an in-phase signal to one of the input
5 electrodes to deflect a first portion of the resonator in a first direction and applying
6 an out-of-phase signal to another input electrode to deflect a second portion of the
7 resonator in a second direction opposite the first direction to force the resonator into
8 a correct mode shape.

1 4. The method as claimed in claim 2 wherein the
2 micromechanical filter apparatus includes an input electrode formed on the substrate
3 to allow electrostatic excitation of the resonator and wherein the step of forcing
4 includes the step of applying a signal to the input electrode, the resonator and the

5 input electrode defines a capacitive transducer gap therebetween and wherein the
6 micromechanical resonator further includes $m+1$ spacers having a height and which
7 extend between the resonator and the substrate at the $m+1$ nodal points and wherein
8 the $m+1$ spacers force the resonator into a correct mode shape during the
9 application of the signal to the input electrode.

1 5. A micromechanical filter apparatus for filtering signals to
2 obtain a desired passband of frequencies, the apparatus comprising:

3 a substrate;
4 a plurality of intercoupled micromechanical elements including a
5 resonator; and
6 a support structure anchored to the substrate to support the elements
7 above the substrate wherein the support structure and the resonator are both
8 dimensioned so that the resonator is isolated from the support structure during
9 resonator vibration wherein energy losses to the substrate are substantially
10 eliminated and wherein the apparatus is a high-Q apparatus.

1 6. The apparatus as claimed in claim 5 wherein the support
2 structure is attached to the resonator at at least one nodal point of the resonator.

1 7. The apparatus as claimed in claim 5 wherein the signals are
2 RF signals.

1 8. The apparatus as claimed in claim 7 wherein the apparatus is
2 an RF filter apparatus.

1 9. The apparatus as claimed in claim 5 wherein the apparatus is
2 a bandpass filter apparatus.

1 10. The apparatus as claimed in claim 5 wherein the support
2 structure includes at least one beam attached to a nodal point of the resonator.

1 11. The apparatus as claimed in claim 5 further comprising at least
2 one input electrode formed on the substrate to allow electrostatic excitation of the
3 resonator wherein the resonator and the at least one input electrode define a
4 capacitive transducer gap therebetween.

1 12. The apparatus as claimed in claim 11 further comprising at
2 least one spacer having a height, each spacer extending between the resonator and
3 the substrate at a nodal point of the resonator wherein the size of the gap is based
4 on the height of the at least one spacer during pull down of the resonator.

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1 13. The apparatus as claimed in claim 5 wherein the apparatus is
2 a silicon-based filter apparatus.

1 14. The apparatus as claimed in claim 5 wherein the apparatus is
2 a diamond-based filter apparatus.

1 15. The apparatus as claimed in claim 11 further comprising at
2 least one output electrode formed on the substrate to sense output of the apparatus.

1 16. The apparatus as claimed in claim 5 wherein the support
2 structure includes a plurality of beams and the resonator includes a plurality of nodal
3 points and wherein each of the beams is attached to the resonator at one of the nodal
4 points of the resonator so that the resonator sees substantially no resistance to
5 transverse or torsional motion from the support structure.

1 17. The apparatus as claimed in claim 11 wherein a pair of
2 balanced input electrodes are formed on the substrate to allow electrostatic excitation
3 of the resonator.

1 18. The apparatus as claimed in claim 15 wherein a pair of
2 balanced output electrodes are formed on the substrate to sense output of the
3 apparatus.

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1 19. The apparatus as claimed in claim 5 wherein the plurality of
2 intercoupled micromechanical elements includes a pair of intercoupled end
3 resonators.

1 20. The apparatus as claimed in claim 19 wherein the support
2 structure supports the end resonators above the substrate.

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1 21. The apparatus as claimed in claim 19 wherein the plurality of
2 intercoupled micromechanical elements further includes an inner resonator
3 intercoupled to the end resonators.

1 22. The apparatus as claimed in claim 21 wherein the support
2 structure supports the end and inner resonators above the substrate.

1 23. The apparatus as claimed in claim 21 wherein the plurality of
2 intercoupled micromechanical elements further include a plurality of coupling links
3 for coupling the inner resonator to the end resonators.

1 24. The apparatus as claimed in claim 23 wherein the coupling
2 links are operable in multiple modes.

1 25. The apparatus as claimed in claim 23 wherein the coupling
2 links are higher mode coupling beams.

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